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*Embodied decision-making during interactive behavior in a dynamic world*

Historically, high-order brain functions linking perception and action have been described as serial processes, following the traditional view of cognitive psychology. In this framework, decisions are computed in a central executive system, outside of the sensorimotor systems, and motor structures only implement the selected movement without any real-time influence of the sensory/cognitive context in which the movement is performed. However, animals constantly interact with a complex and ever changing environment. This makes a serial process inefficient because decisions have to be continuously updated during ongoing actions. In a set of experiments, we test the more pragmatic hypothesis that the sensorimotor system is directly involved in making choices. We also address the computational mechanism that transforms relevant information into neural activity in these structures.

Using reach-decision tasks in which sensory evidence varies within and between trials, we first demonstrated that neural activity in monkey premotor (PMd) and motor (M1) cortex tracks the state of sensory information guiding the deliberation. The choice is made when this quantity reaches a commitment threshold about 280ms before movement onset. Micro-stimulation in these regions as well as neural recordings in the prefrontal cortex confirm that decisions about actions are determined in motor regions, in contrast with the central executive hypothesis. We also recently proposed that to make such decisions, subjects do not accumulate the relevant sensory information as predicted by most models in the field, but instead quickly estimate and combine it with a growing urgency signal that pushes the system to commit as time passes. We found that decision-related activity in PMd and M1 is compatible with this urgency-gating model and we found that the brain adapts its speed-accuracy trade-off (SAT) by adjusting the urgency level as a function of the task context, allowing animals to maximise what they care about the most: the reward rate.

Finally, we observed that the same urgency signal that governs the SAT during decision-making also influences the way movements are executed to report the decision. Preliminary analyses suggest that this common signal is controlled by basal ganglia (BG). We believe that this observation of a tight relationship between decision and action regulation within the BG opens a new and broad territory of research to investigate both the basic mechanisms of reward-oriented interactive behavior and the causes of many degenerative syndromes associated with deficits in cognition and motor control, including Parkinson disease.